Who done it? Searching for clues with sediments

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The sediments near Horn Richterswil – today a recreation and bathing resort on Lake Zurich – are contaminated with toxic metals, particularly mercury. On behalf of the Canton of Zurich, Eawag researchers have used sediment cores to reconstruct when the pollutants entered the lake. In this way, they could help clarify the origin of the contaminants.

The Contaminated Sites Ordinance obliges all cantons to check polluted sites for contamination and to decontaminate them where necessary. In 2013, the Canton of Zurich's Cantonal Office for Waste, Water, Energy and Air (AWEL) therefore commissioned the aquatic research institute Eawag and several engineering firms to examine the lake bed near Horn Richterswil for contamination. The adjacent area of land had been used as an industrial site for over 100 years before it became the property of the Canton of Zurich in 1976 and the Commune of Richterswil in 2020. It has been a public recreation and bathing resort since the mid-1980s. So there are many people who relax there where industrial wastewater used to be discharged into Lake Zurich.

The investigations did indeed bring to light numerous toxic metals: lead, cadmium, chromium, copper, nickel, zinc, arsenic, tin and mercury. The highest concentrations were found for lead. However, mercury was particularly worrying, as this is the most hazardous, not only for the lake ecosystem and the plants and animals living in it, but also for humans. Consequently, AWEL assessed the contaminated sediments near Horn Richterswil as in need of decontamination.

Who released the pollutants into the lake?

There is no statute of limitations for causing environmental pollution in Switzerland. In the event of a necessary clean-up operation, polluters may be obliged to bear part of the often high decontamination costs, provided that the contamination can be clearly attributed to them. The results of the

investigations carried out in 2013 did not allow any conclusions to be drawn as to who was and is responsible for the contamination in the lake. So the question arose: Who done it?

The question was not easy to answer, as various industries had been active at Horn Richterswil since the middle of the 19th century. From 1854 to 1862, a silk factory was located there, which was subsequently used for dyeing silk. In 1926, the site was sold to a company that printed cotton there for three years. Between 1928 and 1976, the last industrial enterprise to operate on the site was a rubber factory.

Eawag researchers have taken several sediment cores from Lake Zurich at Horn Richterswil. This core comes from a moderate distance from the shore. On the left are the oldest layers, on the right the most recent layers. (Photo: Remo Röthlin)

Sediments tell astonishing stories

In order to identify possible polluters, AWEL commissioned Eawag in 2016 to determine the exact chronological course of the pollution. “One way to look back into the past is through sediment cores,” explains Nathalie Dubois, head of the Eawag Sedimentology Research Group and professor at the ETH Zurich. Sediments are formed at the bottom of the lake by the deposition of rock particles such as sand or loess and dead aquatic organisms. Each year, a new layer is formed that can be dated with the help of scientific methods and thereby assigned to a specific year. Since pollutants also sink to the bottom in the water and are deposited in the sediments, the history of the contaminants can be reconstructed with the help of the drill cores.

In the years 2016 and 2017, Remo Röthlin, who did his master’s thesis with Nathalie Dubois and Bernhard Wehrli, former department head at Eawag and professor at the ETH Zurich, took 14 sediment cores at different sites at Horn Richterswil together with other Eawag researchers. Layer by layer, the researchers examined the sediments and analysed them for traces of heavy metals using X-ray fluorescence core scanners as well as various geochemical and elemental analyses. In this way, the research team was able to elicit interesting facts from the drill cores and determine the chronological sequence of the contamination.

This sediment core originates from the deep areas of Lake Zurich. The younger part of the core (right) is laminated, i.e. it has fine annual layers and can therefore be used for dating the layers. (Photo: Remo Röthlin)

Detective work: on the trail of the perpetrators

“Most of the metals probably flowed into Lake Zurich with industrial wastewater,” explains Remo Röthlin. “We can distinguish between two stages.” In a first stage, as early as around 1880, chromium, copper, lead and tin entered Lake Zurich, presumably from the textile industry. Later, between 1950 and 1960, other pollutants, namely zinc and cadmium, entered

the water. “Zinc and cadmium, which we found in higher concentrations along the shore, probably came from the rubber factory,” Remo Röthlin explains. Zinc was used in the vulcanisation of rubber. Since zinc and cadmium are often found together in nature, cadmium also entered the lake as a waste product.

The researchers found mercury in various layers, the highest concentrations in a special humus layer, i.e. a layer that, in contrast to the sediment layers, consists mainly of soil. The researchers therefore suspect that the mercury originates not only from the Horn Richterswil industrial site, but possibly also from other locations. The mercury in the humus layer could first have been deposited on the shore in the form of contaminated soil and subsequently washed into the lake by heavy rain or shore slides. “However, these are only conjectures, we cannot prove this scientifically,” adds Remo Röthlin.

This sediment core was taken near the shore. The brown part on the left is the humus layer mentioned in the article. The dark grey layers on the right are lake sediments (Photo: Remo Röthlin)

The research findings are an important basis for the Canton of Zurich

However, Eawag’s new investigations not only uncovered the industrial polluters, they also found significantly higher concentrations of the pollutants at the bottom of the lake than had been suspected in the initial investigations. “The concentrations of all the metals detected exceeded the prescribed threshold limits for the environment. Mercury even by a factor of 10,000,” says Remo Röthlin. Although the elevated levels do not pose a risk to human health because they are bound in the sediments, they could be hazardous to organisms living at the bottom of the lake. There is also the danger that the pollutants, particularly mercury, will accumulate in the food chain and thus become hazardous for humans in the long term.

The precise temporal allocation of the contamination shown in the research findings was an important basis on which AWEL was able to oblige the rubber factory, which is still operating today, to assume part of the clean-up costs. As negotiations on funding were ongoing until recently, the scientific results of the study could not be published until 2022. The decontamination of the contaminated sediments is being planned and will be carried out in the next few years.

Cover picture: Historical photo of Horn Richterswil on the shore of Lake Zurich. (Source: https://ba.e-pics.ethz.ch/catalog/ETHBIB.Bildarchiv/r/581286, edited by Water Science Policy)

Original publication

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Related Links

Roethlin, R., & Dubois, N. (2022) 'Sedimentary tales - Lake Zurich's industrial past' Water Science Policy

Report from AWEL, Canton of Zurich: Project “KbS Lakes”, survey of contaminated sites in the lakes of the Canton of Zurich, final report

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